

# **D&D TECHNOLOGY COST BENEFIT ANALYSES**

Abstract # 139

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## **ABSTRACT**

Funded by the Department of Energy (DOE), the goal of the Accelerated Site Technology Deployment (ASTD) Integrated Decontamination and Decommissioning (ID&D) project is to put new, proven technologies to use in decontamination and decommissioning operations. Although the scope of the ASTD project did not include collecting detailed cost savings data, it was necessary to document the overall cost savings and benefits of using the technologies deployed to convince potential technology users of the advantages. Using novel approaches and various information sources, the Idaho National Engineering and Environmental Laboratory (INEEL) engineers calculated the overall savings of the new D&D technologies deployed at the INEEL during FY-99.

During FY-99, seven different technologies were successfully deployed at the INEEL with an eighth delayed until FY-00 resulting in an estimated cost saving of almost \$700K. The cost benefit calculation approaches were different for each technology. Some were very straightforward, such as comparing the number of new soft-sided waste containers used to the number of metal waste boxes that would have been required for a particular waste stream. Other cost benefit calculations were more innovative. For example, the amount of fuel consumed by the new oxy-gasoline torch was used to calculate the inches cut and the cost compared to the baseline acetylene torch. Techniques used to estimate cost saving for each technology are presented in this paper.

Cost and benefit information is needed to enable subsequent deployment of these technologies at other DOE and commercial sites. The overall goal is to reduce costs and improve safety and productivity of D&D operations.

## **INTRODUCTION**

The overall goal of the Accelerated Site Technology Deployment (ASTD) Integrated Decontamination and Decommissioning (ID&D) project is to increase the use of innovative, proven technologies for completing Decontamination and Decommissioning (D&D) tasks. These new technologies can provide improvements over baseline methods in areas such as cost, schedule, radiation exposure, waste volume, and safety. Besides providing benefits to the sites demonstrating these technologies, this project is intended to increase their use throughout DOE and commercial nuclear sites. This can be accomplished by increasing personnel experience and familiarity with the selected innovative technologies. However, other sites may still not utilize these new technologies unless they can save a significant amount of time and money or significantly increase worker safety. The deployment projects must document these savings and benefits to convince other locations to use the technologies.

Unlike the formal technology demonstration projects, the ASTD deployment project baseline did not include collecting detailed cost savings information. With a limited budget and resources, tracking of actual deployment costs was not possible. Using novel approaches and various information sources, the Idaho National Environmental and Engineering Laboratory (INEEL) engineers calculated the overall savings of these new D&D technologies which were deployed at the INEEL during FY-99.

## **COST BENEFIT APPROACHES**

Seven different technologies were successfully deployed at the INEEL under the ASTD ID&D in FY-99 with an eighth delayed until FY-00 resulting in an estimated cost saving of almost \$700K. During the deployment period, the use of the technologies was tracked primarily by speaking with the field personnel using the technologies. A call or site visit was made about once each week to collect information on the technologies used, locations of use, length of use, and opinions from the experienced field crews on how the new technology compared with the old or baseline technologies. It was not possible to track each element that affected the cost of these deployments. However, a “rough order of magnitude” cost benefit for each technology was needed to aid in obtaining subsequent deployments. The cost benefit calculations were specifically tailored for each technology.

### **Soft-Sided Waste Containers**

Soft-sided waste containers are polypropylene bags that are supported by a loading frame while being filled with waste. A special lifting bar is used to pick up and place the filled bags in a staging area or on a transport vehicle. They were deployed to replace 4’x4’x8’ rigid metal waste boxes on many INEEL projects. The cost benefit calculation approach for the soft-sided waste container deployment was very straightforward. A previously conducted Large Scale Demonstration and Deployment Project (LSDDP) had completed a detailed evaluation of the soft-side waste container against the metal waste boxes normally used at the INEEL. Information from the LSDDP Innovative Technology Summary Report (ITSR) was used to obtain container volumes and container costs (1). The ITSR indicated that three metal boxes at \$970 each (including filling cost) were needed for each soft sided container used at \$895 each. The number of soft-sided containers used during the ASTD project was obtained from the various site project managers. It was then a simple matter of calculating the cost of metal box use versus the cost of soft-sided container use. The estimated overall saving for the use of the soft-sided containers at the INEEL during FY-99 was about \$353K (175 soft-sided units used).

### **Automatic Locking Scaffold System**

A deployment using an automatic locking scaffold system (the Excel system) was also conducted during FY-99. The vertical supports of the Excel system have cups every 5 ¾” for horizontal bar attachment by means of a spring-loaded, positive locking trigger mechanism. This scaffolding was deployed in place of the usual tube and clamp scaffolding.

The Automatic Locking Scaffold System ITSR tracked actual set-up, useage and takedown times for both the Excel and the tube and clamp system (2). It was not tracked to that level of detail during the ASTD deployments. Therefore, information on the quantity, footprints (area) and heights of the various setups was collected from the D&D carpenter setting up the scaffolding on the various site projects (Table I, Column A). The carpenter also indicated the approximate length of time the setups were in place (Table I, Column B).

As outlined in the ITSR, the cost of using the Excel scaffolding was based on its amortized purchase price. The ITSR indicated \$0.53/hour for Excel scaffolding use, however, this did not include overhead costs of 31.5%. When these costs are added and the purchase price amortized over 10 years at 5.8% interest for 1000 hours of use per year, the calculated rate is \$0.71/hour of use. Since this is based on the parts needed to construct a 420-ft<sup>3</sup> scaffold, ratios were used tp obtain an appropriate cost of equipment use (Table I, Column C). This rate was multiplied by the number of hours the scaffolding was left in place (Table I, Column D). The cost of using tube and clamp scaffolding was similarly calculated to be \$0.35/hour of use (Table I, Column I).

The cost of mobilizing the Excel scaffolding included staging the scaffolding, which according to the ITSR takes 15 minutes with one carpenter (\$45.50/hr) and one laborer (\$41.07/hr) and an equipment rate of \$0.71/hr for a total of **\$21.82**. The labor rates used in the ITSR did not include all overhead costs that are included in this analysis. Mobilization included a 30-minute pre-job briefing for the carpenter, laborer and job supervisor (\$65.44/hr) and the equipment rate of \$0.71/hr for a total of **\$68.08**. Mobilization also included the scaffolding setup at a production rate of 540 ft<sup>3</sup>/hr by one laborer and one carpenter and included the equipment rate of \$0.71/hr for this time. The cost of setting up the Excel scaffolding calculated to be **\$0.16/ft<sup>3</sup>**, which is then multiplied by the volume of the setup to obtain the total costs (Table I, Column E). Staging the tube and clamp scaffolding took 40 minutes with one equipment operator (\$47.12/hr) with an hourly tube and clamp scaffolding cost (\$0.35/hr) and forklift cost (\$3.30/hr) for a total of **\$33.81**. Mobilization included a 30-minute pre-job briefing for the carpenter, laborer and job supervisor and the scaffolding equipment rate of \$0.35/hr for a total of **\$76.20**. The tube and clamp scaffolding setup production rate was 300 ft<sup>3</sup>/hr by one laborer and one carpenter and included the scaffolding equipment rate of \$0.35/hr and miscellaneous small tools rate of \$0.17/hr. The cost of setting up the scaffolding was calculated to be **\$0.29/ft<sup>3</sup>**, which is then multiplied by the volume of the setup to obtain the total cost (Table I, Column H).

The cost of Excel demobilization included storing the scaffolding, which takes 15 minutes with one carpenter (\$45.50/hr) and one laborer (\$41.07/hr) and the equipment rate of \$0.71/hr for this time for a total of **\$21.82**. It also included the Excel scaffolding teardown at a production rate of 1800 ft<sup>3</sup>/hr by one laborer and one carpenter and included the equipment rate of \$0.71/hr. The cost of tearing down the Excel scaffolding was calculated as **\$0.05/ft<sup>3</sup>**, which is multiplied by the volume of the setup (Table I, Column F). Storing the tube and clamp scaffolding took 40 minutes with two equipment operators with a scaffolding rate of \$0.35/hr plus the forklift rate of \$3.30/hr for a total of **\$33.18**. It also included the scaffolding teardown at a production rate of 402 ft<sup>3</sup>/hr by one laborer and one carpenter and included the scaffolding rate of \$0.35/hr and miscellaneous tools rate of \$0.17/hr for this time. The cost of tearing down the tube and clamp scaffolding was calculated as **\$0.22/ft<sup>3</sup>**, which is multiplied by the volume of the setup (Table I, Column J).

Adding the mobilization, use and demobilization costs showed that use of the Excel scaffolding saved \$1950 in FY-99 (Table I, Columns G&K). Despite the seemingly low savings, the scaffolding was seen as a big improvement over the tube and clamp by the D&D carpenter. In almost all instances he preferred to work with the new scaffolding and felt it reduced the chances of injury due to the ease of setup. In higher radiation areas, the ease of construction would also lead to significant reduction in personnel exposure.

Table I. Scaffolding Cost Benefit Analysis

A Setup Vol. (ft3)	B Job Time (hrs)	C Excel Use Rate \$/hr	D Excel Work \$	E Excel Mobilize \$	F Excel Demob \$	G Excel Total \$	H T&C Mobilize \$	I T&C Work \$	J T&C Demob \$	K T&C Total \$	L Cost Difference \$
6X10X15= 900	80	1.52	121.71	233.9	66.82	422.43	371.01	60	231.81	662.82	240.39
6X10X15= 900	80	1.52	121.71	233.9	66.82	422.43	371.01	60	231.81	662.82	240.39
8X12X10= 960	80	1.62	129.83	243.5	69.82	443.15	388.41	64	245.01	697.42	254.27
8X12X10= 960	80	1.62	129.83	243.5	69.82	443.15	388.41	64	245.01	697.42	254.27
3X6X13= 234	80	0.40	31.65	127.34	33.52	192.51	177.87	15.6	85.29	278.76	86.25
5X7X12= 420	80	0.71	56.80	157.1	42.82	256.72	231.81	28	126.21	386.02	129.3
1354	80	2.29	183.11	306.54	89.52	579.17	502.67	90.27	331.69	924.63	345.46
7X8X6= 336	80	0.57	45.60	143.70	38.62	227.92	207.45	22.40	107.73	337.58	109.66
5X7X14= 490	80	0.83	66.40	168.30	46.32	281.02	252.11	32.67	141.61	426.39	145.37
5X7X14= 490	80	0.83	66.40	168.30	46.32	281.02	252.11	32.67	141.61	426.39	145.37
											1950.73

C=(A/420)\*0.71 – ratio of setup vol times amortized equipment cost

D=B\*C - hours worked times amortized equip. cost

E=21.82 staging + 68.08 briefing + (0.16\*A) equip setup

F=21.82 staging + (0.05\*A) equip teardown

G= D+E+F - total cost

H=33.81 staging + 76.20 briefing + (0.29\*A) equip setup

I=B\*(0.35\*(A/420)) added G&A and PIF to equipment cost (not in ITSR)

J=(0.22\*A) + 33.81 added G&A to labor costs (27%) (not in ITSR)

K=H+I+J

L=K-G

## Oxy-Gas Torch

The gasoline fueled oxy-gas torch is considered a safer replacement for the standard oxy-acetylene torch for cutting carbon steel. During deployment of the oxy-gas torch at the INEEL, it was used at several facilities and locations for cutting a variety of materials (pipes, plate, rebar, etc.). It was not possible to track actual time used or inches of cuts made to do a cost benefit analysis as was done in the LSDDP ITSR (3). The only reasonable way to determine the deployment cost savings was to note the number of gallons of gasoline used and equate that to the number of inches cut and cost savings using the data obtained from the oxy-gas torch ITSR.

The Oxy-Gas Torch ITSR compared oxy-acetylene torch cutting to oxy-gas torch cutting for metal thicknesses of 0.5 inch to over 4.5 inches. Length of cuts and unit cost (\$/in) are summarized in Table II.

Table II. Summary of ISTR information on oxy-gas and oxy-acetylene torches.

Thickness	≤ 0.5 in	1.0 in	1.75 in	2.0 in.	4.5 in.	Overall
Oxy-gas Length (in)	166.5	35	43	120	4.5	369
Oxygas Unit Cost (\$/in)	\$0.62	\$0.92	\$1.01	\$0.64	\$2.53	\$0.90
Oxy-acetylene Length (in)	166.5	35	43	108	4.5	357
Oxy-acetylene Unit Cost (\$/in)	\$0.63	\$1.05	\$1.18	\$1.12	\$7.75	\$1.19

The ITSR also states that accurate fuel consumption data could not be collected during only those times when the torches were being demonstrated, therefore, “since the total demonstration time for each torch was approximately one work day, fuel consumption was estimated to be a typical work day’s usage which, in the case of the Fernald Energy Management Project (FEMP), is 2.5 gallons of gasoline...”. This indicates one gallon of gas was used to cut 148 inches (369 inches per tank / 2.5 gallons per tank) with the oxy-gas torch.

At one INEEL facility, the oxy-gas torch was used to cut 14” and 16” diameter water pipe about 3/8”-1” thick using 4 gallons of gasoline. This equates to 592 inches of metal cut (148 inches/gal \* 4 gal) at a cost of \$533 (592 inches \* \$0.90/inch). To cut 592 inches of metal with the oxyacetylene torch would cost \$704 (592 inches \* \$1.19/inch). Therefore, \$112 was saved at this facility by using the oxy-gas torch. If the costs for cutting 2” thick metal were used (i.e. a 50% savings), the savings would be on the order of \$300.

A second INEEL facility used the oxy-gas torch to cut 1” and 2” plate and railroad track. The operator indicated he thought it worked 3-4 times faster than the baseline torch. Approximately 3 tanks of gas (2.5 gallons/tank) were used which equates to 1100 inches cut at a cost of \$704 (if using the 2” cutting costs from the above table (\$0.64/in)). To cut the same amount with the

baseline torch would cost \$1232. Therefore the oxy-gas torch has saved \$528 (if only 2 times as fast). If it actually cut 4 times faster, the savings would be more on the order of \$1500.

At a third facility, the oxy-gas torch was used to cut ½” to 1” thick rebar. Approximately one tank of gas was used savings around \$100. And at a fourth facility, approximately 2 tanks of gas were used saving around \$200. This brings the overall cost savings for use of the oxy-gas torch at the INEEL during FY-99 to \$900-\$2100.

Although actual savings are minimal, the perception by the workers is it cuts 2-4 times faster and is much easier to use. Feedback from the field on the oxy-gas torch was very positive. It is lighter and easier to handle than the oxy-acetylene torch, the thicker metal cuts do not have to be preheated first, and it reduces worker fatigue. One operator indicated, “the more I use it the more I like it”. The savings are not as apparent in the dollars saved because actual “cutting time” is so small. More of the time is used to actually set-up the cuts versus doing the cutting. To save \$10,000, the oxy-gas torch would have to be operated enough to use 25-50 tanks of gas. In general, the sites at which the torch is used need it only for occasional cutting and do not have it in constant operation for day after day. The oxy-gas torch is considered safer because it produces less metal slag and will not explode the concrete as acetylene torches can.

### **BROKK Remote Demolition Robot**

The BROKK BM250 robot is a remote-controlled demolition system that replaces hand-held equipment like jackhammers. Numerous end effectors can be attached to the BROKK, so it can do a variety of tasks from scabbling to shearing. The BROKK was used with a hammer attachment and a shear attachment at the INEEL in FY-99. The hammer was used to break two 3-foot diameter holes in a floor for creating negative airflow during asbestos removal in a basement. The floor was concrete with an unexpected cast iron plate in it. It took only 15 minutes to set up the hammer and 1 hour for two operators to make the required hole. It is difficult to compare this activity with a baseline as the workers weren’t sure how they would have been able to make the hole through the cast iron plate (a hand held jackhammer & torch would not have been able to do this).

The shear was also used to remove piping from the walls and drop it on the floor to gain access to an asbestos covered duct above the piping. A crew of 2 personnel worked for 3 days at this activity. In addition, it was used for one day to remove some HVAC ducting for a total work time of 40 hours. This cost-benefit analysis was based only on the use of the shear.

The total cost for using the BROKK includes the equipment useage cost, the labor training costs, the labor setup costs and the actual labor work costs. The INEEL purchased a radio controlled BROKK for \$118,372 and a LaBounty shear for \$18,000. A service life 15 years was estimated with a total use of 1000 hours per year. Using an interest rate of 5.8%, the amortized cost of the use of the Brokk with the shear was calculated to be \$19.37/hour. Prior to use of the Brokk, approximately 60 hours of training were required and a \$10/hr equipment maintenance time was used based on manufacturer recommendations. Therefore, the total equipment useage cost was (60 hrs training time + 40 hours work time)\*\$19.37 + \$10/hr (40 hours work time)=\$2337.

Training was conducted for 2 operators (\$45.50/hr) for 60 hours each. It also took 2 operators 90 minutes to set up the shear and four ten-hour days to complete the job. The Job Site Supervisor (JSS) was required for 1 hour/day for 4 days (\$65.44/hr). This gives a total labor cost for this job of \$8560.

Without the BROKK and shear, this job would have been completed by setting up scaffolding and using a crew of 4 people with hand tools to cut and lower the pipe and ducting to the floor. Since the cost of this equipment is low, it was assumed that the equipment useage cost was negligible. The JSS indicated the job went at least 10 times faster using the BROKK shear. If the job performance was 10 times longer using the hand tools the same job would take 40 days to perform with a crew of 4 people and the JSS for 40 hours. This would give a total job cost of about \$75,500.

For this one job, the savings using the BROKK and shear were estimated to be about \$67K. In addition, the BROKK greatly increased worker safety, as personnel did not have to be in areas with falling pipes and use of scaffolding was not required. The schedule for the completion of the D&D project was also accelerated.

### **Personal Ice Cooling Suits**

The Personal Ice Cooling Suits (PICS) use a system of tubing for circulating ice-cooled water to remove excess body heat controlling heat stress, increasing productivity and improving worker comfort. The PICS were used during FY-99 D&D dismantlement work at an INEEL facility contaminated with heavy metals such as lead, cadmium and arsenic. Workers were required to wear full protective equipment including respirators at a 90°F ambient temperature. The work was moderate to heavy and continuous, including tasks such as taking piping off walls, removing insulation, and cutting tanks. Use of the PICS cooling vests allowed the workers to more than double their stay times while doing this heavy work.

Although ten hour shifts are worked at the facility, pre-job briefings, scheduled breaks and work cleanup reduce actual work to approximately 6.5 hours per day. The training time for the PICS was negligible (only about 10 minutes). Using information from the PICS ITSR (4) the following work cycle times were determined both for with and without the PICS when using full PPE (Table III).

Table III. Work cycle times with full PPE.

	Baseline Work Cycle (min)	PICS Work Cycle (min)
Stay time	90	180
PPE don	10	20
PPE doff	10	13
Rest time	45	0
Total Work Cycle	155	213

Therefore, for a baseline (without PICS) work period of 6.5 hours, a total of 3.8 productive hours per day (6.5 hours \* 90 min/155 min) can be completed. This is 38 % efficient (3.8 hours/10

hours). For a PICS work period of 6.5 hours, a total of 5.5 productive hours per day (6.5 hours \*180 min/213 min) can be completed for an efficiency of 55 % (5.5 hours/10 hours).

The PICS were used on this job for a total of 19 days (190 hours) by a crew of six people for a total of 1140 hours (6 people\*190 hours/person). The loaded labor rate is approximately \$45/hour for a cost of \$51,300. For the baseline the same amount of work would have taken 1650 hours (1140 hours \*(0.55/0.38)). At a labor rate of \$45/hr this is \$74,250. Therefore, the PICS saved about \$22,950 in labor costs for this job.

In addition, PPE costs were also saved. In the ITSR analysis (4), the PPE used was very similar to that being worn at the INEEL facility. The ITSR calculated cost for baseline PPE was \$14.93/hr, which would cost \$24,635 for the estimated baseline hours. The ITSR calculated cost for innovative PPE was \$8.12/hr, which would cost \$9,257 for the estimated innovative hours. This is a saving of \$15,378.

The PICS deployment was highly successful in reducing costs during the INEEL deployment, realizing savings of \$38,328. In addition, the workers liked the system and were much more comfortable while using it. The packs were worn under the PPE and on top of lightweight modesty clothing. To change the ice bottles (3-4 times per day per person) the PPE was cut open, the ice bottle changed and the PPE retaped. The workers washed the vests daily when they showered. This approach would need to be evaluated for every situation as some contamination conditions may preclude slitting open the PPE. In these cases special PPE with an equipment flap could be used.

## **Concrete Crusher**

Normally, uncontaminated concrete from structures undergoing demolition at the INEEL is placed into dump trucks and taken to an onsite landfill. The dump trucks are then used to bring in clean, gravel fill material from an onsite gravel pit for backfilling at the D&D site. An alternative method is to use a concrete crusher to size the uncontaminated concrete pieces to 1-2" diameter and reuse the crushed concrete as the site fill material.

D&D Operations at the INEEL purchased a concrete crusher for \$450,000. This crusher will be deployed in early FY-00 to crush uncontaminated concrete rubble and reuse it to fill in the excavation. Assuming a service life of 30 years, an average use of 160 hours per year and a 5.8% interest rate, the amortized crushing equipment useage cost was calculated to be \$279/hour. For this analysis, it was assumed that the front loader and other equipment to move crushed gravel from the pile to the hole was equivalent to the equipment needed to fill dump trucks at the landfill for the baseline case – therefore it was not counted in either case.

According to the JSS, it took two operators and one maintenance person 20 hours each (\$45.50/hour) to complete the maintenance and setup of the crusher for a set-up cost of \$2730. The JSS estimated that 3 weeks of actual operation time and 1 week of demobilization time would be required to crush the concrete at the job site. This is sixteen ten-hour workdays. The JSS was required at least 1 hr/day (\$64.45) for 16 days. Three operators were required for 3 weeks (120 hours) to run and feed the crusher. Four operators were required to move crushed



gravel to fill the hole for 40 hours each. Shutting down the equipment took two operators 20 hours each. This yields an overall cost of approximately \$74K for using the crusher.

Normally, since this concrete was not contaminated, it would have been loaded into a dump truck and taken to the landfill. The equipment useage cost for 2 dump trucks was calculated to be \$21.20/hour. Approximately 4200 yd<sup>3</sup> concrete was generated for disposal and same amount of fill is required. A dump truck holds about 10 yd<sup>3</sup> (including void spaces). Therefore, 420 truckloads will be needed (4200 yd<sup>3</sup>/10 yd<sup>3</sup> per truckload). It was assumed that it required 1 hour to fill the truck at the job site then drive to and dump it in the landfill, get gravel and return to the job site. Therefore, each truck can make 10 trips/day so 42 days would be required. The costs to complete this scenario include:

- One operator for front loader for 420 hours to load concrete @ \$45.50/hr = \$19,110
- Two operators for dump trucks for 420 hours to go to landfill get gravel and return @ \$45.50/hr each = \$38,220
- One job site supervisor for 0.5 hour per day for briefing @ \$65.45/hour = \$1374
- Cost of landfill (\$26/ton \* 0.0748 tons/ft<sup>3</sup>) \* (4200 yd<sup>3</sup> \* 27 ft<sup>3</sup>/yd<sup>3</sup>) = \$220,540
- One operator for front loader for 420 hours to load gravel @ \$45.50/hr = \$19,110

Fill material at the INEEL is free. However, fuel costs for the dump truck would be about (420 round trips \* 10 miles/trip) /3 miles/gallon) \* \$3/gallon = \$4200. This brings the overall cost for dumping the concrete to the landfill to \$302.5K. Therefore, the estimated saving of using the concrete crusher is about \$229K.

### **Decontamination, Decommissioning and Remediation Optimal Planning System**

The Decontamination, Decommissioning and Remediation Optimal Planning System (DDROPS) is a special computer interface that provides an optimal size reduction and packaging plan for tanks, piping, and other dismantled equipment. DDROPS was used to create a 3-D model an INEEL facility in FY-99. The 3-D model was created in Pro-Engineer using blueprints of the facility. It shows all of the piping, pumps, valves, tanks, and other possibly contaminated materials in the facility. The DDROPS cutting optimization program was then used to determine the optimal cutting/segmentation locations in the existing piping. The resulting “cut pieces” were then virtually packaged into waste boxes. A total of between one and two 4’x4’x8’ virtual waste boxes (144 ft<sup>3</sup>) were required to contain the material. The actual facility was dismantled with normal D&D operational techniques (without the benefit of the optimal cutting locations). The dismantlement resulted in filling between five and six 4’x4’x8’ waste boxes (700 ft<sup>3</sup>). This indicates potential savings of four to five waste boxes (556 ft<sup>3</sup>) at a cost of approximately \$700 each for a \$3500 saving. In addition, although at the INEEL the cost of LLW disposal is not charged to the D&D projects, at commercial sites the cost ranges from \$100/ft<sup>3</sup> to \$700/ft<sup>3</sup>. The potential saving for a 556-ft<sup>3</sup> waste reduction is between \$56K and \$389K.

DDROPS was also deployed at an INEEL underwater reactor system scheduled for D&D by creating a 3-D model of the reactor. This deployment was used to help the workers visualize the reactor geometry when choosing the dismantlement technique. Animation of the dismantlement further helped in both determining the methods for deploying the various cutting techniques and in the calculation of worker exposures from deploying these techniques. In addition, the

DDROPS 3-D model was used to calculate the center of gravity and weight of the reactor assembly for design of the lifting bracket.

## **GammaCam**

The GammaCam is used to identify radiation hot spots in an area and provides a 2-D color image of gamma radiation fields placed on a video image of the area scanned. In FY-99, the GammaCam was used to gain “before and after” information on the equipment used for the Three Mile Island (TMI) fuel evaluations in a hot shop. As stated in the ITSr (5), the GammaCam is not a replacement for manual surveying as it does not give quantitative information. Therefore, this analysis focused on the cost of deploying the GammaCam and the benefits it provided and did not compare it to manual surveying.

This technology was used twice; once prior to handling the TMI fuel, and again after handling the TMI fuel. The Remote Systems Engineering group at the INEEL purchased a GammaCam for \$184,900 and a special enclosure was built to provide contamination control for \$9600. Using a service life of 20 years and assuming the equipment is used 40 hours per year, gives an equipment useage cost of \$583/hour.

For each deployment, a statement of work took ½-1 day to complete (one radcon engineer for 5 hours at \$55/hr and one robotics engineer for 5 hours at \$52/hr). During each setup, it took two robotics engineers three hours to prepare the equipment and cover the cables with plastic to prevent contamination. The labor during the 2-hour period the GammaCam was taking readings is summarized below:

- One Job Supervisor for 2 hours during activities @ \$65.44/hr = \$131 \* 2 deployments = \$262.
- Two robotics engineers to run camera and do cable management for 2 hours while taking readings @ \$52.24/hr = \$209 \* 2 deployments = \$418
- One Radiation Control Technician (RCT) to provide in cell communication and to line up the 7 shots for 2 hours @ \$27.49/hr = \$55 \* 2 deployments = \$110
- One operator to move camera positions for 2 hours while taking readings @ \$45.50/hr = \$91 \* 2 deployments = \$182

After data were collected it took two robotics engineers two hours to decontaminate the equipment, obtain data printouts and transport the GammaCam back to storage @ \$52.24/hr = \$209 \* 2 deployments = \$418. One RCT was also needed to verify the equipment was decontaminated for 15 minutes @ \$27.49/hr = \$7 \* 2 deployments = \$14

Using a total 14-hour useage time for the equipment costs, gives an overall deployment cost of \$19.7K. The majority of the cost of deploying the GammaCam was in the equipment cost – primarily because this equipment is expensive and is only used once or twice a year at the INEEL. The labor costs totaled approximately \$3400.

The GammaCam has been used to reduce radiation exposure to personnel by identifying the hot spots without extensive hand metering – this can target the areas needing decontamination or shielding. The potential for cost savings in reduced radiation exposure levels is significantly

higher than the cost of deployment considering that each man-rem saved is worth approximately \$6000.

## **SUMMARY**

Eight different technologies were deployed at the INEEL under the ASTD ID&D. The cost benefit calculation approaches were different for each technology. Some were very straightforward, such as comparing the number of the new soft-sided waste containers used to the number of metal waste boxes that would have been required. Other cost benefit calculations were more innovative, such as using the amount of fuel consumed by the new oxy-gasoline torch along with data from the DOE Large Scale Demonstration and Deployment Project (LSDDP) to calculate the inches cut and the cost compared to the baseline acetylene torch. The techniques used for each technology are detailed in this paper.

Even though the information is not highly precise, it is still useful in portraying the extent of the benefit obtained by deploying the technology. These cost benefits can be calculated with a minimum of cost and data collection when using previously gathered cost information and field labor resources. Similar approaches can be used on other projects with other technologies to provide a valid rough order of magnitude comparison while spending only a small amount on engineering cost benefit analysis. The calculated cost savings and benefits information will aid in obtaining subsequent technology deployments at other DOE and commercial sites. The overall goal is to reduce costs and improve safety and productivity of D&D operations.

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